Evaluation of cleaning solvents for Asian lacquers

Steven Saverwyns[1*], Jonas Veenhoven[1,2,5], Delphine Mesmaeker[3], Nathalie Vandeperre[3], Henk van Keulen[4], Maarten van Bommel[5], Frederic Lynen[2]

[1] Royal Institute for Cultural Heritage (KIK/IRPA), Laboratories Department, Brussels, Belgium
[2] Ghent University, Separation Science Group, Ghent, Belgium
[3] Royal Museums of Art and History (RMAH), East Asian Collections, Brussels Belgium
[4] Cultural Heritage Agency of the Netherlands (RCE), Cultural Heritage Laboratory, Amsterdam, Netherlands
[5] University of Amsterdam, Conservation and Restoration of Cultural Heritage, Amsterdam, Netherlands

The science of Buddha

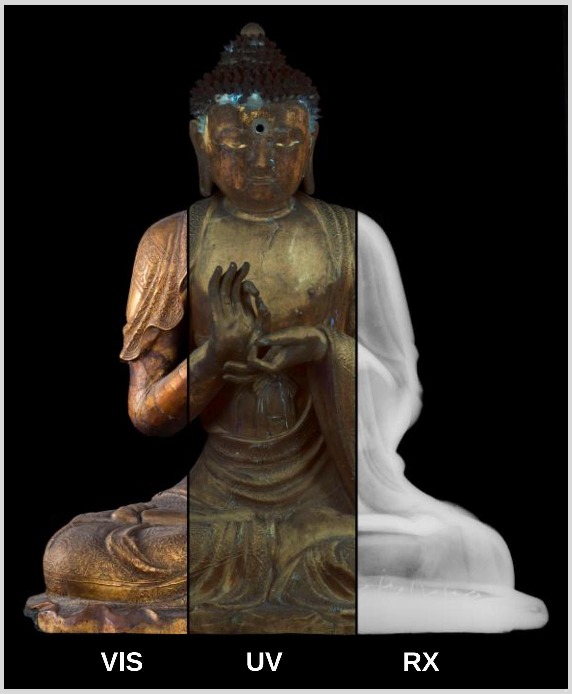

***Figure 1:** Buddha seated in meditation position (padmasana), hands making the gesture of teaching (vitarka mudra). China, 17th century, H.113 x 89 cm. Acquired by the RMAH in 1955.*

The object was identified as a dry lacquer sculpture (夾紵 *jiazhu*). Being unique in the museum collection, it is the first object to be cleaned within the PHySICAL project.

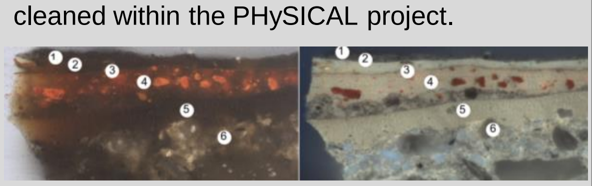

***Figure 2:** Optical light microscopy images of cross-sections from the Buddha statue under VIS and UV illumination, with layer annotations.*

Layer	Name	Analytical result
1	Top surface	Wax layer
2	Lacquer layer	Urushi, soot, rapeseed- and tung oil
3	Metal foil/lacquer	
4	Lacquer layer	
5	Lacquer layer	
6	Ground layer	Jutte fibres, urushi, soot and carbohydrates + proteins (tofu?)
7	Ground layer/textile	
8	Ground layer	
9-20	Alternating textile- and ground layers	

***Table I:** THM-Py-GC-MS results.*

The PHySICAL project

The project focusses on the scientific study of the cleaning of light-degraded Asian lacquer (more info on http://physical.kikirpa.be/).
In this contribution solvent induced leaching on artificially aged Asian lacquer mock-up samples is chemically investigated using gas chromatography coupled to mass spectrometry; results are related to physical changes of the samples, such as color and gloss. Solvent-extractive sampling and identification is for the first time applied to an object in the collection of the RMAH.

Cleaning… which solvent?

For an initial assessment of cleaning solvents, an international survey on cleaning materials used in conservation practice was completed by 121 respondents. 47% used unmodified water as aqueous solution. The usage of solvents was as follows: ethanol (26%), acetone (10%), Shellsol D40 (17%) and cyclomethicone D5 (9%). The effects of solvents on the aged lacquer surface were studied more in detail.

GC-MS and THM-Py-GC-MS on solvent leachables

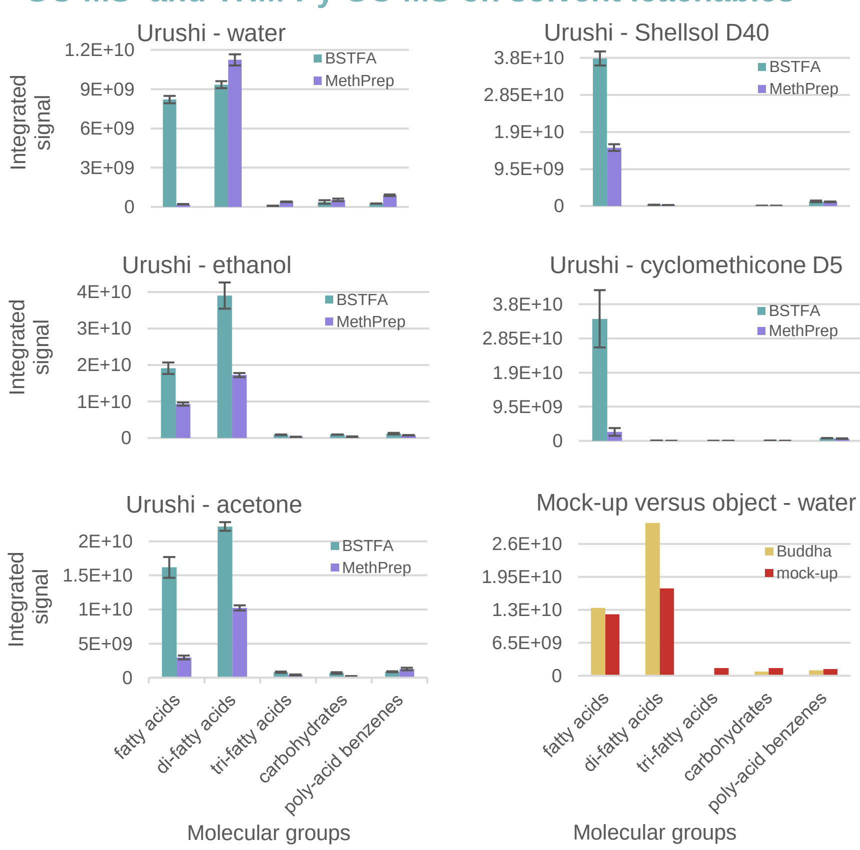

***Figure 3:** Peak area totals of molecular groups identified with GC-MS in extracts after derivatization with BSTFA and MethPrep II, in separate series.*

Polar extracts typically contain poly-acid benzenes, di- and tri-carboxylated fatty acids, while apolar extracts consist of predominantly monocarboxylic fatty acids. In other words, soluble surface compounds contain mostly carboxylic groups, which are in essence weak acids. Conversely, surface pH of the mock-ups was found to be around 4, reflecting the high concentration of carboxylic groups. Poly-acid benzenes can have up to five carboxylic acids attached directly on the benzene ring [1]. They are therefore important denominators in the results of surface acidity and polarity. Two derivatization methods were used in order to obtain as complete a picture as possible of the leachables; especially for the important poly-acid benzenes derivatization with MethPrep II appeared to be more efficient.
Extrapolating the methodology to the Buddha statue of the museum, which was analyzed with THM-Py-GC-MS, showed to be comparable to the results obtained on a mock-up, with exception of di-fatty acid peak area differences, which was attributed to the drying oil present in the lacquer formulation of the object.

Physico-chemical experiments

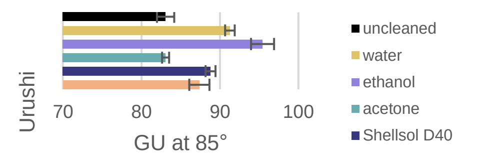

***Figure 4:** Gloss measurements before and after solvent application on an aged urushi mock-up.*

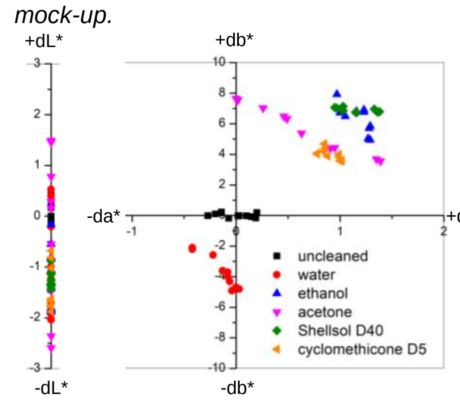

***Figure 5:** CIELAB (L*a*b*) color measurements before and after solvent application on an urushi mock-up.*

Use of solvents caused heterogeneous color changes, with a shift towards a warmer yellowish tone, with the exception of water, which caused a slight shift to a cooler tint. Discrepancies in color obtained after water application compared to solvents is clear. Gloss measurements showed that polar solvents yielded a more pronounced gloss increase, with exception of acetone. In principle polar solvents remove degradation compounds from the surface, revealing a less degraded surface. The modifications, however, both color and gloss could only be measured. Visible changes were only seen in VIS and UV-light after water application.

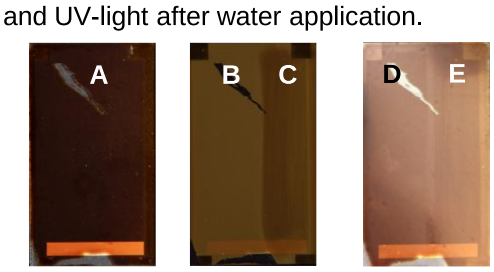

***Figure 6:** UV and VIS photography on an urushi mock-up. **A**: unaged (UV), **B**: aged (UV), **C**: aged and after water application (UV), **D**: aged (VIS) and **E**: aged and after water application (VIS).*

Conclusion

Cleaning lacquer with polar solvents extracts more compounds and increases the gloss of the lacquer. Solvents cause a shift to warmer yellowish L*a*b* color values, while for water a cooler shift is observed. Solvent extractive sampling of the surface of an object leads to similar results as obtained for the mock-ups. Further research is scheduled to study the long-term effects of solvent cleaning.

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References

[1] Han et. al, ICOM-CC post prints, 2021